#30 Appeal Brief Barkley 11/21/02

PATENT APPLICATION

Our File No. 960514.CNC

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Re App	:	JOHN R. MOSER, JR.	:	October 28, 2002
S.N.	:	09/088,163	:	Art Unit 3641
Filed	:	June 1, 1998	:	Examiner E. Miller
For	:	REDUCED ENERGY BINDER FOR ENERGETIC COMPOSITIONS		

BRIEF FOR THE APPELLANT

1. REAL PARTY IN INTEREST

The real party in interest in this Appeal is Alliant Techsystems Inc., a corporation organized and existing under the laws of the State of Delaware, and having its principal office located at 5050 Lincoln Drive, Edina, Minnesota 55436-1097, by virtue of an Assignment from the inventor, recorded June 1, 1998, at Reel 9223, Frames 0241-0244.

2. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to the patent owner, the patent owners legal representative or the inventors which will directly affect or be directly affected by or have a bearing on the Board of Patent Appeals and

Interferences in this pending Appeal to the present knowledge of the undersigned.

3. STATUS OF CLAIMS

The present application is a continued prosecution application (CPA) in a non-provisional patent application filed June 1, 1998, Serial No. 09/088,163. The CPA contained claims 38-64, claims 1-37 having been cancelled in previously submitted papers. Claims 38, 43, 44, 53 and 54 were cancelled pursuant to a response dated December 10, 2001. Thus, claims 39-42, 45-52 and 55-69 are pending in this application and were the subject of this Appeal as listed in the Notice of Appeal filed June 26, 2002.

In this Brief, however, appellant, in the interest of reducing issues and expediting the application, hereby cancels claims 40-42, 45-50 and 68 and offers amendments to claims 39, 51-52, 62-63, 65 and 69, which are rewritten as follows:

39(Twice Amended). A propellant composition as in claim [65] 67 wherein the energetic plasticizer is a nitrate ester plasticizer selected from the group consisting of nitroglycerin, n-butyl-2-nitratoethyl nitramine and trimethylolethane trinitrate and combinations thereof.

51(Four Times Amended). An improved high solid propellant composition comprising by weight:

(a) about 10% cured poly(tetramethylene adipate) cured from a [hydroxy-terminated] tetramethylene adipate prepolymer Mw_n ≥6000 [binder polymer] using an isocyanate curing agent;

(b) about 11% nitroglycerin plasticizer;

(c) about 2.5% triacetin plasticizer;

(d) about 22% aluminum; and

(e) about 53% ammonium perchlorate oxidizer.

52(Four Times Amended). An improved high solids propellant composition comprising by weight:

(a) about 7% cured poly(tetramethylene adipate) cured from a [hydroxy-terminated] tetramethylene adipate prepolymer, Mw_n ≥6000 [binder polymer] using an isocyanate curing agent;

(b) about 6.5% n-butyl-2-nitratoethyl nitramine;

(c) about 1.4% triacetin;

(d) about 22% aluminum;

(e) about 60% ammonium perchlorate; and

(f) about 2% dicyandiamide.

62(Four Times Amended). An improved high solids propellant composition comprising by weight:

(a) about 11% cured poly(tetramethylene adipate) cured from a [hydroxy-terminated] tetramethylene adipate

prepolymer, MW_n about 6,000 [binder polymer] using an isocyanate curing agent;

(b) about 12% plasticizer selected from the group consisting of nitroglycerin and trimethylolethane trinitrate and combinations thereof;

(c) about 22% aluminum; and

(d) about 53% ammonium perchlorate.

63(Four Times Amended). An improved high solids propellant composition comprising by weight:

(a) about 11.3% cured poly (tetramethylene adipate) cured from a [hydroxy-terminated] tetramethylene adipate prepolymer, MW_n about 6,200 [binder polymer] using an isocyanate curing agent;

(b) about 12.2% nitroglycerin plasticizer;

(c) about 22% (30μ) aluminum; and

(d) about 53% (200μ) ammonium perchlorate oxidizer.

65(Amended). An improved propellant composition comprising a fuel, reduced energy binder, and an oxidizer, wherein said reduced energy binder consists essentially of:

(a) [an amount of one or more cured high molecular weight adipate binder polymers, including] an amount of poly(tetramethylene adipate) [wherein said one or more isocyanate-cured adipate binder polymers are] cured

from uncured [hydroxy-terminated adipate prepolymers] tetramethylene adipate prepolymer using an isocyanate curing agent and wherein the molecular weight (MW_n) of the uncured poly(tetramethylene adipate) prepolymer is [above 4000] at least 6000; and

(b) an amount of energetic plasticizer wherein the plasticizer to polymer ratio is less than about 1.6:1.

69(Amended). A reduced energy binder for energetic compositions consisting essentially of:

(a) [an amount of one or more cured high molecular weight adipate binder polymers including] an amount of poly(tetramethylene adipate) [wherein said one or more isocyanate-cured adipate binder polymers are] cured from uncured [hydroxy-terminated adipate prepolymers] tetramethylene adipate prepolymer using an isocyanate curing agent and wherein the molecular weight (MW_n) of the uncured poly(tetramethylene adipate) prepolymer is at least 6,000; and

(b) an amount of energetic plasticizer wherein the plasticizer to polymer ratio is less than about 1.6:1.

What appellant believes to be a true copy of the claims remaining under appeal as presently configured through the

amendments submitted herein appears in Appendix A attached to the end of this Brief.

4. STATUS OF AMENDMENTS

All amendments previously submitted in this application are believed to have been entered and are presently considered to be of record.

5. SUMMARY OF THE INVENTION

The invention is directed to improvements in energetic compositions or formulations, particularly solid high energy compositions including propellants, explosives, gas generators and such materials. These materials generally contain particulate solids in the form of oxidizers, fuels, burning modifiers, solid explosives and other additives dispersed in elastomeric binders.

The elastomeric binders themselves generally have contained amounts of high energy, hazard-sensitive plasticizers such as nitrate esters, for example, nitroglycerin. While these plasticizing materials increase the hazardous nature of the mixture, they have long been employed because they are known to enhance the mechanical properties, as well as the energy output of the overall composition. The better the mechanical properties, the easier it is to work and shape the mixed composition as desired, perforate, etc. The binders further

contain an amount of generally inert polymer material in the form of cured prepolymers. The polymer portion has generally been a minor amount of the binder, there being two-four parts of energetic plasticizer to one part of polymer.

More recently, more stringent requirements imposed for lower hazard sensitivity have led to increased demand for lower energy, although not entirely inert, binders which enable the compositions to pass hazard sensitivity testing.

One approach to this problem is to reduce the ratio of plasticizer to polymer binder material in the composition, however, at the resultant lower plasticizer: polymer (Pl:Po) ratios, the lower fraction of plasticizer was insufficient to properly plasticize the binder polymer and this resulted in unsatisfactory mechanical properties, especially with regard to low elongation.

Specifically, there remained a need in the art to produce a binder composition and thus a propellant composition in which the binder polymer was fully plasticized at lower Pl:Po ratios to reduce hazards sensitivity without sacrificing good mechanical properties.

The invention involved a discovery that solves the foregoing problems by providing unique binder compositions that employ a cured high molecular weight poly(tetramethylene

adipate) or PTMA cured from a prepolymer using an isocyanate curing agent. The material is particularly effective if the molecular weight of the prepolymers (MW_n) is at least 6000.

The polyester polymer materials of the invention are so readily plasticized by energetic plasticizers including nitrate esters such that the relative level of high energy plasticizers can be reduced significantly without sacrificing mechanical properties in the final propellant composition. Thus, when used with NG at an approximate Pl:Po ratio of 1:1 or even slightly less, the polymer is sufficiently plasticized to enable excellent or superior mechanical properties to be realized. The PTMA can also be used with other energetic plasticizers such as those listed on page 5, lines 17-20 of appellant's specification.

In addition, the resultant binder compositions have been discovered to have other important and previously unrecognized advantageous characteristics. One of these is that the binders of the invention have relatively high electrical conductivity which reduces the risk associated with the accumulation or buildup of large static charges in the associated energetic compositions. Furthermore, the binders of the present invention enable the formulation of propellant compositions that can use lower cost energetic materials without sacrificing

propellant properties. For example, the material has allowed the formulation of low-binder-energy propellant that enables the elimination of expensive HMX or RDX from the formula and inclusion of lower cost AP oxidizer and aluminum or other solids combinations in the mix. Specific propellant formulae are found in Tables I, III, V, VII and IX. A list of ingredient functions pertaining to the formulae is found on page 7, beginning at line 6. Properties of the formulae are found in other tables.

It is in this manner that the unique binder systems further enable unique propellant formulations of greatly improved safety.

Note, for example, in Table I, the high ratio of PTMA to NG and high amounts of AP and AL, the low amount of BuNENA which is less than the amount of PTMA in the formula of Table III. Table V shows a formula in which the amount of PTMA exceeds that of NG and Table VII shows a combination of PTMA and TMETN. All the formulas have eliminated the common and expensive HMX or RDX from the composition.

The nature of the binder is so important in determining the properties of the resulting propellant that it has become customary in the art to refer to propellant types by calling out their binder names. Propellant's binder, thus, not only reduces the hazardous nature of compositions utilizing the binder, but

also imparts improved mechanical electrical, etc., properties to the composition far beyond anything that could have been anticipated.

6. ISSUES ON APPEAL

A. 35 USC § 112

While certain issues were raised by the Examiner with regard to all the claims in the final rejection under 35 USC § 112, second paragraph, with regard to indefiniteness, these are believed to have been addressed by suggested changes in the claims offered in Section 3 of this Brief. Thus, the term "binder polymer" has been removed from claim 51, line 5, and claims 52 and 63, line 5 and other places where it may have been confusing. The terminology referring to the prepolymer as tetramethylene adiptate prepolymer has been made consistent throughout and the language made consistent with regard to stating that cure is accomplished using an isocyanate curing agent. The above having been accomplished, it is now believed that the language of the remaining claims is clear and consistent and that this issue has been removed from this Appeal.

B. 35 USC § 103(a)

The statutory provision of 35 USC § 103(a) is believed to form the sole remaining basis for the rejections of claims on

appeal and these rejections are based on two combinations of references as follows:

i. Claims 39, 51-52, 55-67 and 69 (all the remaining claims) stand rejected under 35 USC § 103(a) according to the final rejection as being unpatentable over Bradford et al (U.S. 5,271,778) in view of Chi (U.S. 5,074,938), Willer (U.S. 5,240,523) and Flemming (U.S. 5,583,315) as per paragraph 2 of Paper No. 6 (mailed November 12, 1999).

ii. Claims 39, 51-52, 55-67 and 69 are also rejected under 35 USC § 103(a) as being unpatentable over Sutton et al (U.S. 3,362,859) in view of Hauser et al (U.S. 3,632,632), Godfrey (U.S. 3,203,842), Genetti et al (U.S. 4,102,868) and Kangas (U.S. 5,536,805).

Given the above-enumerated rejections, it is the Examiner's opinion that all claims under appeal are unpatentable based on the combinations of patents as recited above.

In view of the foregoing, it appears that the main issue to be decided in this Appeal addresses the question as to whether the combinations of patents cited by the Examiner can be said to

properly render the relevant claims unpatentable under 35 USC § 103(a).

7. ARGUMENTS

A. Grouping of Claims

Appellant believes that each and every claim should stand or fall on its own merits and that the limitations of each should be considered separately. Each claim is directed to a particular combination of elements utilized either in the binder or in a propellant composition and so while some seem similar, each claim is directed to a particular combination of elements utilized in the formulation of a particular embodiment within the scope of the invention and it is believed that each stands in a different relation to the art. This is true event though the main thrust of the arguments be directed to the independent claims with respect to the combinations of cited art. This is also believed true even though the claims be grouped together in each of the rejections. Note that the binders, for example, contain different combinations with plasticizers and the formulas for the propellants contain different proportions of different ingredients.

B. The Cited Art

The art from 6(B) Item (i) above is as follows:

1. Bradford et al (U.S. 5,271,778)

Bradford et al describe a stable chlorine-free solid rocket propellant composition which contains a low energy binder containing polyglycol adipate prepolymer (PGA) in combination with certain energetic binder materials such as triethylene glycol dinitrate (TEGDN).

2. Chi (U.S. 5,074,938)

The Chi reference also is directed to a propellant grain which includes an amount of a cured polymeric binder which includes poly(diethylene glycol) adipate (PGA) as described in Column 5, lines 6-8.

3. Willer (U.S. 5,240,523

Willer discloses a propellant composition which includes an elastomeric binder and plasticizers therefore the elastomeric binders may be polyether or polyester-based and they include PGA and as recited in the cited passage, Column 3, lines 3-6, may have molecular weights from 2000 to about 20,000.

4. Flemming (U.S. 5,583,315)

Flemming describes a propellant with long shelf life and of a clearly different composition, but one which may include an amount of dicyandiamide, an ingredient in the propellant composition of claim 52 in half the amount disclosed in Flemming.

With respect to rejection 6(B) (ii) under 35 USC § 103(a), the following patents were cited:

1. Sutton et al (U.S. 3,362,859)

Sutton et al is concerned with solid fuel compositions and particularly is related to the combustion characteristics of such compositions. As part of their description, they do present a discussion on fuel binders beginning at Column 4, line 28. In that discussion, they do mention isocyanate-terminated linear polyesters having a molecular weight ranging from 500 to 15,000, among many other compounds, and preferably having a molecular weight from about 500 to 15,000 and preferably from 5000 to 12,000. That patent talks only in sweeping generalities, not identifying specific compounds.

2. Hauser et al (U.S. 3,632,632)

This reference discloses certain binder combinations which may include saturated diols such as trimethylene glycol which is mentioned buried in a list of many compounds at Column 2, line 15.

Godfrey (U.S. 3,203,842

Admitted as cumulative by the Examiner, the Godfrey reference discusses curing agents for polyester resins generally.

3. Genetti et al (U.S. 4,102,868)

This reference is directed to the composition and making of certain polyester-urethane polymers and has nothing to do with the uses of such polymers. It does disclose PTMA at Column 6, line 15.

4. Kangas (U.S. 5,536,805)

The Kangas reference, like Genetti et al, is directed only to certain polyurethane prepolymers and also shows the existence of polyesterpolyol prepolymers having molecular weight (M_n) between 2000 and 10,000, but is unrelated to the appellant's use and reveals nothing that would lead one to use such compounds for anything related to propellant binders.

C. Authorities and Arguments

In determining the propriety of a rejection under 35 U.S.C. § 103, based on a combination of references, it is well settled that the obviousness of an invention cannot be established by combining the teachings of the prior art absent some teaching, suggestion or incentive supporting the combination. See In re Fine, 837 F.2d 1071, USPQ 2d 1596 (Fed. Cir. 1988); Ashland Oil, Inc. v. Delta Resins and Refractories, Inc., 776 F.2d 281, 227 USPQ 657 (Fed. Cir. 1985); ACS Hospital Systems, Inc. v. Montefiore Hospital, 732 F.2d 1572, 221 USPQ 929 (Fed. Cir. 1984). This is not to say that the claimed invention must be expressly suggested in any one or

all of the references. Rather, the test for obviousness is what the combined teachings of the references taken as a whole would have suggested to those having ordinary skill in the art. See Cable Electric Products, Inc. v. Genmark, Inc., 770 F.2d 1015, 226 USPQ 881 (Fed. Cir. 1985); In re Kaslow, 707 F.2d 1366, 217 USPQ 1089 (Fed. Cir. 1983); In re Keller, 642 F.2d 413, 208 USPQ 871 (CCPA 1981).

The burden for establishing a prima facie case of obviousness, however, is upon the Examiner to present evidence that would have led one of ordinary skill in the art to combine the relevant teachings of the references to arrive at the claimed invention. This burden can only be satisfied by showing an objective teaching in the prior art or by knowledge generally available to one of ordinary skill in the art that would have led the way for such individual to combine the relevant teachings of the references. A rejection based on §103 must rest on a factual basis with the facts being interpreted without hindsight reconstruction of the invention from the prior art. In making this evaluation, the Examiner has the initial duty of supplying the factual basis for the rejection he advances. The Examiner may not, because of doubt that he invention is patentable, resort to speculation, unfounded assumptions or hindsight reconstruction to

supply deficiencies in the factual basis. See In re Warner, 379 F.2d 1011, 154 USPQ 173 (CCPA 1967).

Focusing on the obviousness of substitutions and differences instead of the invention as a whole has also been found to be a legally improper way to simplify the difficult determination of obviousness. Hybritech Inc. v Monoclonal Antibodies, Inc., 233 USPQ 81 (CAFC 1986). The mere fact that the prior art may be modified in a manner suggested by the Examiner does not make the modification obvious unless the prior art itself suggests the desirability of the modification. In re Fritch, 23 USPQ 2d 780 (CAFC 1992).

The extent to which such suggestion must be explicit in, or may be fairly inferred from, the references, is decided on the facts of each case, in light of the prior art and its relationship to the Appellant's invention. It is impermissible, however, simply to engage in a hindsight reconstruction of the claimed invention, using the Appellant's structure as a template and selecting elements from references to fill the gaps. The references themselves must provide some teaching whereby the Appellant's combination would have been obvious. In re Gorman, 933 F.2d 982, 986, 18 USPQ2d 1885, 1888 (Fed. Cir. 1991) (citations omitted). That is, something in the prior art as a whole must suggest the desirability, and thus the obviousness, of

making the combination. See In re Beattie, 974 F.2d 1309, 1312, 24 USPQ2d 1040, 1042 (Fed. Cir. 1992); Lindemann Maschinenfabrik GmbH v. American Hoist and Derrick Co., 730 F.2d 1452, 1462, 221 USPQ 481, 488 (Fed. Cir. 1984).

Given the above state of the art, Appellant believes that no combination of the cited references, each being taken for what it contributes as a whole, and at the time the claimed invention was made, supports the substitutions or modifications suggested by the Examiner to reject the present claims. Appellant believes that it is only through hindsight and in light of the teachings of Appellant's own specification that the substitutions and modifications suggested by the Examiner would be implemented. A discussion follows.

With respect to the first rejection, based on the Bradford et al '778 reference taken in view of Chi '938, Willer '523 and Flemming '315 it is believed that prior submissions by the appellant have made it clear that PGA disclosed by Bradford et al, Chi and Willer is a distinct and separate compound from appellant's PTMA. This was previously supported by an exhibit attached to Paper No. 7 dated January 11, 2000 of that Amendment in the form of a report from Chemical Abstracts. The compounds are not equivalent nor, it is submitted, are they abvious in view of each other in view of the numerous possible compounds

utilizable as binder polymers in the realm of propulsion compositions which may seem somewhat similar in structure. The enhanced mechanical characteristics observed with the present formulae do not occur with PGA nor would one be led to believe that they would follow in the compounds of the present invention given the lack of success in those areas with PGA.

Whereas substitutions of alternative polymers and binders are possible, without specific teachings directing one toward this substitution of certain polymers, an exhaustive amount of experimentation would be necessary in order to arrive what might be a promising substitute. One skilled in the formulation of energetic composites knows that a successful formulation using one binder polymer does not guarantee success using another binder polymer and that the ultimate processability and end use properties cannot be interchangeably anticipated from the polymer used. Finally, the fact that Flemming teaches the use of It is believed that prior submissions have made it clear that PGA disclosed by Bradford et al, Chi and Willer is a distinct and separate compound from Appellant's PTMA. This was previously verified by an exhibit attached to Paper No. 7 dated January 11, 2000 of that Amendment. The compounds are not equivalent nor are they obvious in view of each other in view of the numerous possible compounds utilizable as binder polymers in the realm of propulsion compositions. The enhanced mechanical characteristics

observed with the present formulas do not occur with PGA nor would one be led to believe that they would follow in the compounds of the present invention given the lack of success in those areas with PGA. Whereas substitutions of alternative polymers and binders are possible, without specific teachings directing the substitution of certain polymers, an exhaustive amount of experimentation would be necessary in order to arrive what might be a promising substitute. One skilled in the formulation of energetic composites knows that a successful formulation using one binder polymer does not guarantee success using another binder polymer and that the ultimate processability and end use properties cannot be interchangeably anticipated from the type of polymer used. The fact that Flemming teaches the use of dicyandiamide in a diverse formula is not believed particularly relevant to the presently claimed compositions. Appellant does not claim to be the first ever to use that compound in the propellant formulation. It is the whole combination that is sought to be patented. That reference as a whole teaches little of any relevance.

With respect to the second rejection under the prolific combination of five (5) patents, that combination is believed to be no closer than that earlier applied. Whereas Sutton et al '859 (at Column 5, lines 54-57) mentions a preference for "carboxyterminated, hydroxy-terminated, and isocyanate-terminated

linear polymers having a molecular weight ranging from 500 to 15,000 and preferably from 5,000 to 12,000, etc.", they are clearly talking generalities and do not mention PTMA, the compound of interest. It is noted also that all the actual examples in that reference are limited to lower molecular weight (about 2,000) of carboxy-terminated PGA and another carboxy-terminated polyester (Witco F-17-80) with a molecular weight of 1550. This clearly indicates a preference for lower molecular weights.

Hauser et al '632 does mention PTMA as one of a long list of many suitable polymers, but there also indicates no preference for PTMA over others, let alone the use of PTMA of a specific molecular weight minimum and proportion.

Godfrey '842 includes a long list of polyesters, but does not specifically include PTMA.

Genetti et al '868 and Kangas '805 do disclose PTMA in a totally different context as one of among many possible polyesters which exist and can be produced.

The Appellant in this application, of course, does not to profess to have invented PTMA, per se, but only to have discovered that PTMA cured from prepolymers of certain higher molecular weights impart unpredictably good properties to binder and resulting propellant compositions for several reasons, none of which are pointed out as predictable attributes which would lead

one to select that compound other than by working backward from Appellant's formula utilizing hindsight.

It is submitted that the Examiner has failed to establish and maintain a *prime facie* case of obviousness based on either combination of patents, combinations of those patents, taken as a whole, would not lead one to the claimed binders or claimed propellant compositions of the present application.

It remains the Appellant's view that only through hindsight reconstruction could one given the diverse combination of cited and applied art come up with a binder or propellant composition which would render any of the claims in the present application obvious. There is simply nothing contained considering these references as a whole which would have suggested what the inventor has discovered and it was only using the Appellant's own disclosure as a blueprint to reconstruct the claimed invention that one could come up with the conclusions necessary to support the present rejections. This clearly is not in line with the present state of the law.

See, e.g., Grain Processing Corp. v. American Maize-Products Co., 5USPQ 2d 1788, 1792 (Fed. Cir. 1988) and in re Flitch 23USPQ 2d 1780 (CAFC 1992). The CAFC has also cautioned against focusing on the obviousness of the differences between the claimed invention and the prior art rather than on the obviousness of the

claimed invention as a whole as § 103(a) requires. See, e.g., Hybritech Inc. v. Monoclonal Antibodies, Inc., 231 USPQ 81, 93 (Fed. Cir. 1986), cert. denied, 480 U.S. 947 (1987).

CONCLUSION

Appellant believes that the Examiner has not sustained the burden for establishing and maintaining a prima facie case of obviousness given either set of combined references and, therefore, the rejections based on 35 USC § 103(a) should not stand. The Appellant is convinced that each of the present propellant formula claims is unique and patentably distinct from either set of prior art references and that, likewise, each of the binder claims is unique and patentable. The Appellant

respectfully requests that the final rejection by the Examiner be reversed and the claims allowed.

Respectfully submitted,

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CERTIFICATE OF MAILING

I hereby certify that the foregoing Brief for the Appellant in triplicate, in application Serial No. 09/088,163, filed on June 1, 1998, of John R. Moser, Jr., entitled "REDUCED ENERGY BINDER FOR ENERGETIC COMPOSITIONS" is being deposited with the U.S. Postal Service as First Class mail in an envelope addressed to Commissioner of Patents and Trademarks, Washington, D.C. 20231, postage prepaid, on October 28, 2002.

Barbara L. Davis
Secretary to C. G. Mersereau
Attorney for Appellant
Date of Signature: October 28, 2002

APPENDIX A TO APPELLANT'S BRIEF

APPEALED CLAIMS

39. A propellant composition as in claim 67 wherein the energetic plasticizer is a nitrate ester plasticizer selected from the group consisting of nitroglycerin, n-butyl-2-nitratoethyl nitramine and trimethylolethane trinitrate and combinations thereof.

51. An improved high solid propellant composition comprising by weight:

(a) about 10% cured poly(tetramethylene adipate) cured from a tetramethylene adipate prepolymer $Mw_n \geq 6000$ [binder polymer] using an isocyanate curing agent;

(b) about 11% nitroglycerin plasticizer;

(c) about 2.5% triacetin plasticizer;

(d) about 22% aluminum; and

(e) about 53% ammonium perchlorate oxidizer.

52. An improved high solids propellant composition comprising by weight:

(a) about 7% cured poly(tetramethylene adipate) cured from a tetramethylene adipate prepolymer, $Mw_n \geq 6000$ [binder polymer] using an isocyanate curing agent;

(b) about 6.5% n-butyl-2-nitratoethyl nitramine;

(c) about 1.4% triacetin;

(d) about 22% aluminum;

(e) about 60% ammonium perchlorate; and

(f) about 2% dicyandiamide.

55. A reduced energy binder as in claim 69 further comprising an amount of inert plasticizer.

56. A reduced energy binder as in claim 55 wherein the inert plasticizer is triacetin.

57. A reduced energy binder as in claim 69 wherein the one or more energetic plasticizers are selected from the group consisting of nitrate esters of the group consisting of n-butyl-2-nitratoethyl nitramine; trimethylolethane trinitrate; triethyleneglycol dinitrate; butanetriol trinitrate; nitroglycerin and combinations thereof.

58. A reduced energy binder as in claim 55 wherein the one or more energetic plasticizers are selected from nitrate esters of the group consisting of n-butyl-2-nitratoethyl nitramine; trimethylolethane trinitrate; triethyleneglycol dinitrate; butanetriol trinitrate; nitroglycerin and combinations thereof.

59. A reduced energy binder as in claim 57 wherein the plasticizer is selected from the group consisting of

nitroglycerin, n-butyl-2-nitratoethyl nitramine, trimethylolethane trinitrate and combinations thereof.

60. A reduced energy binder as in claim 58 wherein the plasticizer is selected from the group consisting of nitroglycerin, n-butyl-2-nitratoethyl nitramine, trimethylolethane trinitrate and combinations thereof.

61. A propellant composition as in claim 60 wherein the plasticizer is trimethylolethane trinitrate.

62. An improved high solids propellant composition comprising by weight:

(a) about 11% cured poly(tetramethylene adipate) cured from a tetramethylene adipate prepolymer, MW_n about 6,000 using an isocyanate curing agent;

(b) about 12% plasticizer selected from the group consisting of nitroglycerin and trimethylolethane trinitrate and combinations thereof;

(c) about 22% aluminum; and

(d) about 53% ammonium perchlorate.

63. An improved high solids propellant composition comprising by weight:

(a) about 11.3% cured poly (tetramethylene adipate) cured from a tetramethylene adipate prepolymer, MW_n about 6,200 using an isocyanate curing agent;

(b) about 12.2% nitroglycerin plasticizer;

(c) about 22% (30μ) aluminum; and

(d) about 53% (200μ) ammonium perchlorate oxidizer.

64. The propellant composition of claim 62 wherein (d) comprises about 30% ammonium perchlorate and about 22% sodium nitrate.

65. An improved propellant composition comprising a fuel, reduced energy binder, and an oxidizer, wherein said reduced energy binder consists essentially of:

(a) an amount of poly(tetramethylene adipate) cured from uncured tetramethylene adipate prepolymer using an isocyanate curing agent and wherein the molecular weight (MW_n) of the uncured poly(tetramethylene adipate) prepolymer is at least 6000; and

(b) an amount of energetic plasticizer wherein the plasticizer to polymer ratio is less than about 1.6:1.

66. A propellant composition as in claim 65 wherein said reduced energy binder further comprises an amount of inert plasticizer material.

67. A propellant composition as in claim 66 wherein said inert plasticizer is triacetin.

69(Amended). A reduced energy binder for energetic compositions consisting essentially of:

(a) an amount of poly(tetramethylene adipate) cured from uncured tetramethylene adipate prepolymer using an isocyanate curing agent and wherein the molecular weight (MW_n) of the uncured poly(tetramethylene adipate) prepolymer is at least 6,000; and

(b) an amount of energetic plasticizer wherein the plasticizer to polymer ratio is less than about 1.6:1.